## REMARKS

The application stands with claims 25-31, 33, 36-45, 47-70 and 72-98, where claims 25, 49, 74, 84 and 91 are independent. Claims 30, 31, 51, 56 and 57 are withdrawn. Herein claims 25 and 86 are amended and dependent claim 99 is added for the reasons explained below.

Claim rejections – 35 U.S.C. § 112

Claim 86 has been amended so as to overcome the rejection under 35 U.S.C. § 112, 2nd paragraph, made in section 2 of the office action. A corresponding new claim 99 has been added. Therefore, applicant submits that the rejection is overcome, and respectfully requests that this § 112, 2nd paragraph rejection of claim 86 be withdrawn.

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Claim rejections – 35 U.S.C. § 103

A. Claim 25 has been rejected under 35 U.S.C. § 103(a) as being "unpatentable" over Arino et al. in view of Wheeler and Etherington.

Arino et al. has previously been cited by the Examiner in a § 102 rejection of claim 25 which has been overcome (Office Action mailed October 16, 2002).

Arino et al. disclose a target element for the production of radioactive fission products in a nuclear reactor. The element has a cylindrical vessel with a thin, continuous, uniform layer of fissionable material integrally bonded to its inner walls. The bottom and the top of the cylindrical target element are sealed with stainless steel closures welded in place (column 4, lines 1-3). The top closure has a port, which is sealed to provide an entirely closed system during exposure to the neutron source, as well as at various subsequent stages. Therefore, the

gas contained in the vessel remains confined and stationary, in order to receive the fission fragments to be extracted for the production of certain nuclear species (such as $^{99}Tc^{m}$) while the element is irradiated.

Claim 25 recites an open chamber, inlet means for introducing gas into the chamber and outlet means for evacuating gas circulated through the chamber from the inlet means. In addition, claim 25 states that there is direct contact between the fissile material and gas circulating through the chamber.

This is believed to unambiguously distinguish the structure of fuel arrangement used in the present invention from that of the target element disclosed by Arino et al.

Arino et al.'s teaching is very remote from the subject matter of claim 25 of the present application. Arino et al. fail to disclose gas circulating through the chamber. In contrast, Arino et al.'s vessel is sealingly closed and contains a stationary gas.

The Examiner has made a very surprising reading of the claim language on the Arino et al. reference. The Examiner asserts that the port 12 constitutes both gas inlet means and gas outlet means (although the vessel is sealingly closed in use) simply because the port is used prior to the irradiation to introduce helium and after the irradiation to recover $^{99}Mo$ in the helium buffer. This is not believed to be a proper reading of the claim language, which calls for gas circulating through the chamber. The Examiner further asserts that *"inherently some non-uniform heating of the trapped gas"* would occur if Arino et al.'s vessels were inserted into a reactor core according to Wheeler. This is believed to excessively stretch the claim language. In any case, such internal stirring, if any, would not amount to circulating gas through the chamber as claimed.

Claim 25 has been amended to make it even more explicit that the claimed device has means for providing circulation of flowing gas through said chamber, between inlet means for introducing gas into the chamber and outlet means for evacuating the gas circulated through

said chamber from the inlet means. Even with the Examiner's reading of the claim language (which is traversed), it cannot be said that turbulences due to non-uniform heating would cause the gas to circulate between port 12 and port 12. This simply would not make sense.

Wheeler and Etherington have been cited in combination with Arino et al. as illustrative of nuclear reactor cores surrounded by neutron reflectors. Applicant does not contend that Arino et al.'s target vessel would or would not be suitable for insertion into such reactor core. The question is simply irrelevant to the patentability of the claimed invention which includes features that have no counterpart in those three references. Thus, applicant submits that this § 103(a) rejection of claim 25 based Arino et al. in view of Wheeler and Etherington has been overcome, and respectfully requests that this rejection be withdrawn.

* * *

B. Claims 25, 26, 28, 29, 33, 36-39, 42-45, 49, 50, 52, 54, 55, 58-64, 67-70, 74, 75, 77-81, 84, 85, 87, 88, 91 and 93 have been rejected under 35 U.S.C. § 103(a) as being "unpatentable" over Culver in view of Bingham et al. and Etherington.

The primary reference Culver discloses a nuclear rocket engine including a nuclear reactor 12 and a heat exchanger or recuperator 14. The reactor 12 has fuel assemblies 48 and moderator rods 50. The fuel assemblies 48 are hollow to allow passage of the propellant gas, thus forming "chambers". Referring to figures 1, 2, 6 and 11 (see also column 9, lines 33-66), the propellant, which may be hydrogen, is circulated along the following path: feed line 214 (liquid form), heat exchanger 14 (where it is gasified), turbines 220-222, control drum manifold 28, strut channels 34, reflector channels 52 (around control drums 76), lower reactor plenum 57 (outside bellows members 60), lower reactor support plate holes 59, moderator rods 50, upper reactor support plate holes 59, upper reactor plenum 55, strut channels 40, heat exchanger 14, neutron shield 106, bottom plenum 64, vessel holes 62, bellows members 60, fuel assemblies 48, exhaust plenum 16 and nozzle 6.

Culver fails to disclose the following features recited in each of the independent claims of the present application:

(i) the wall of the chamber has a front face coated with fissile material;

(ii) the fissile material on the front face of the chamber wall is in direct contact-with gas circulating through the chamber.

Re independent claim 25, Culver also fails to disclose the following feature:

(iii) a neutron reflector comprising a thickness of carbon material, in cm, being at least 50/d, where d is the density of said carbon material expressed in $g/cm^3$.

Re independent claim 74, Culver also fails to disclose the following feature:

(iv) fissile material comprising $^{242m}Am$ as a fissile isotope.

Re independent claim 84, Culver also fails to disclose the following feature:

(v) inlet means comprising a porous material of which the wall of said at least one chamber is made.

Re independent claim 91, Culver also fails to disclose the following feature:

(vi) cooling means including a molten metal used as a cooling medium.

The above-mentioned difference (i) has been noted by the Examiner. The Examiner has considered that Bingham et al. would have suggested the claim features that are not disclosed by Culver, except feature (iii) which the Examiner considers as suggested by Etherington. The examiner does not seem to have addressed the feature (vi) of independent claim 91, although this claim was rejected as well.

* * *

Bingham et al. disclose a gas-cooled nuclear fuel element comprised of a plurality of coaxial nested rigid porous cylinders of progressively decreasing circumference to allow positioning of each of the cylinders within the cylinder of the next largest size (column 2, lines 32-39). Each cylinder is made of a reticulated vitreous carbon skeleton of appropriate pore and ligament size, coated with a carbide fuel obtained by annealing uranium, plutonium or americium deposited by vapor deposition coating. After such coating, a protective carbon layer is deposited by chemical vapor deposition, and a final protective layer of zirconium carbide is deposited by chemical vapor deposition (column 3, lines 10-19). Such protective coatings clearly contradict the above feature (ii). However, the Examiner has pointed out that Bingham et al. also mention that the protective coatings may be deleted (column 3, lines 35-36).

This observation does not answer the question of determining whether one skilled in the art would have replaced Culver's fuel assemblies 48 by Bingham et al.'s nested porous cylinders.

The Examiner states that *"one having ordinary skill in the art would have recognized that Bingham et al.'s fuel element is well known in the nuclear rocket art, i.e. it is conventional and advantageous because of its optimum characteristics"*. That statement is respectfully traversed. To conclude that a claimed invention is obvious over a combination of primary and secondary references, there must be an incentive for one skilled in the art to apply the teaching of the secondary reference to the subject matter of the primary reference - i.e., a motivation to combine the references must exist.

It is submitted that there was no such incentive in the present case.

Culver's fuel assemblies 48 are said to be of conventional construction (column 4, line 61). This is understood to refer to an assembly wherein fissile material is housed within a suitable cladding (e.g. Zircalloy, steel, etc.). Culver's fuel assemblies 48 are in the form of cylinders through which the heated gas flows up from the bellows members 60 to the exhaust plenum 16. Moderator rods 50 are placed in the intervals between these cylinders (figure 2). The gas

also flows around the moderator rods 50 and the fuel assemblies 48 when it travels up from the lower reactor plenum 57 to the upper reactor plenum 55.

It would not be acceptable to allow gas to flow through the walls of the cylindrical fuel assemblies 48 of Culver's design, from the space occupied by the moderator rods 50 to the interior of the cylindrical fuel assemblies 48. In its path between the lower and upper reactor plenums 57, 55, the gas needs to cool the reflector assembly 52 and the moderator rods 50 (column 9, lines 45-57) which otherwise would reach excessive temperatures. Downstream of that path, the excess reactor heat thus transferred to the gas is required in the heat exchanger 14 to run the primary feed system 4 as shown in figure 11 (column 9, lines 1-4). Therefore, there cannot be any leaks through the walls of the fuel assemblies.

Bingham et al.'s fuel element is designed for particle bed reactors (PBR's). It is reported to optimize the fuel distribution across the thickness of the elements in order to operate each cylinder at its maximum power level within the heat transfer constraints existing at its radial location (column 2, lines 10-13; column 3, lines 7-10).

In a PBR, it is known that the reactor core is cooled by gas flowing radially inward through an annular particle bed (column 1, lines 11-21), the particles incorporating the fissile fuel. Such trajectory for the gas is shown in the sole figure of the reference.

Therefore, Bingham et al.'s fuel element is not suitable to be installed in Culver's reactor design, as one having ordinary skill in the art would have recognized.

Bingham et al. did not provide any teaching regarding the efficient heat transfer mechanism taught in the present application (e.g. page 6, lines 14-25). Considering both Culver and Bingham et al., those skilled in the art would not have been incited to use the claimed combination of features, because the two references relate to incompatible reactor structures, nor to provide a fuel arrangement such that fission fragments evolved by the fission reaction

are kicked from the chamber walls into the chamber volume containing flowing gas to more efficiently heat up the latter.

It would not have been obvious for those skilled in the art to derive the subject matter of any of the independent claims 25, 49, 74, 84 and 91 of the present application from any combination of the Culver and Bingham et al. references.

The Etherington reference is understood to be applied to the above feature (iii) related to the thickness of the neutron reflector made of carbon. That feature is only present in independent claim 25. It is thus unclear to the Applicant whether it was the Examiner's intention to rely on Etherington for the other independent claims 49, 74, 84 and 91.

The Examiner's reasoning with the Etherington reference has not been understood. Nevertheless, Etherington is not considered to suggest the above feature (i) and (ii) found in all the independent claims, nor to incite those skilled in the art to combine the subject matters of Culver and Bingham et al.

For these reasons, applicant submits that the § 103 rejection of claims 25, 26, 28, 29, 33, 36-39, 42-45, 49, 50, 52, 54, 55, 58-64, 67-70, 74, 75, 77-81, 84, 85, 87, 88, 91 and 93 has been overcome, and respectfully requests that this rejection of each of independent claims 25, 49, 74, 84, and 91 as well as their dependent claims listed here be withdrawn.

* * *

C. In section 6 of the Office Action, dependent claims 27, 53, 76, 86 and 94-98 have been rejected under 35 U.S.C. § 103(a) over the Culver-Bingham et al.-Etherington combination and further in view of Chikin et al.

Each of these claims depends on an independent claim which is allowable for the reasons set forth hereabove. This observation suffices to justify that the dependent claims rejected here are also allowable.

* * *

D. In section 7 of the Office Action, dependent claims 40, 41, 47, 48, 65, 66, 72, 73, 82, 83, 89, 90, 92 and 93 have been rejected under 35 U.S.C. § 103(a) over the Culver-Bingham et al.-Etherington combination.

Each of these claims depends on an independent claim which is allowable for the reasons set forth hereabove. This observation suffices to justify that the dependent claims listed here are also allowable. Furthermore no reference supports the Examiner's view that *"the use of $^{7}Li$ as a substitute coolant for hydrogen in the Culver-Bingham et al.-Etherington combination would be prima facie obvious"*. In the reactor design according to Culver, the propellant gas (hydrogen) is present both inside the cylindrical fuel assemblies and around them, so that there is no room for an additional coolant. The same observation applies to Bingham et al.'s PBR fuel elements. It would make it prima facie unobvious to further provide $^{7}Li$ as a coolant.

* * *

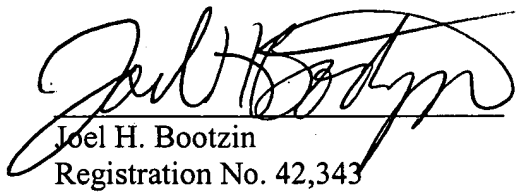
Conclusion

All the claims of the application as amended hereby are believed to be allowable for the reasons explained here above.

Favorable reconsideration and prompt allowance of the application are thus respectfully requested.

No fee is thought to be due in conjunction with the submission of this Amendment. However, the Director is hereby authorized to charge any deficiency to Deposit Account No. 18-2284 of Piper Rudnick LLP, duplicate copy attached.

Respectfully submitted,



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